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Kiran Daundkar
Department of Agricultural Economics Post Graduate Institute Mahatma Phule Krishi Vidyapeeth Rahuri, Dist. Ahmednagar, Maharashtra, India

Dr. VG Pokharkar
Department of Agricultural Economics Post Graduate Institute Mahatma Phule Krishi Vidyapeeth Rahuri, Dist. Ahmednagar, Maharashtra, India

Dr. DB Yadav
Department of Agricultural Economics Post Graduate Institute Mahatma Phule Krishi Vidyapeeth Rahuri, Dist. Ahmednagar, Maharashtra, India

Savita Rathod
Department of Agricultural Economics Post Graduate Institute Mahatma Phule Krishi Vidyapeeth Rahuri, Dist. Ahmednagar, Maharashtra, India

Corresponding Author:
Kiran Daundkar
Department of Agricultural Economics Post Graduate Institute Mahatma Phule Krishi Vidyapeeth Rahuri, Dist. Ahmednagar, Maharashtra, India

Technology adoption and yield gap analysis of major foodgrain crops in western Maharashtra

Kiran Shivaji Daundkar, Dr. VG Pokharkar, Dr. DB Yadav and Savita Rathod

Abstract
The present study was undertaken to study level of technology adoption and yield gap analysis of foodgrain production viz; *rabi* Sorghum, Soybean and Gram. Three major foodgrain crops from the western Maharashtra region viz; *rabi* Sorghum, Soybean and Gram were selected on the basis of important crop from cereals, oilseeds and pulses of the region. Three districts from western Maharashtra region *viz.*, Solapur (*rabi* Sorghum), Sangli (Soybean) and Ahmednagar (Gram) were selected on the basis of maximum area under the respective crop. In *rabi* Sorghum the extent of technology viz; spacing was adopted by maximum 92.63 per cent cultivators at the overall level. It was due to maintain the plant population. About, 85.48 per cent cultivators used the recommended variety. It was due to the good grain and fodder yield of recommended university improved varieties of *rabi* Sorghum. It was also found that, at overall level 80.58 per cent cultivators adopted protected irrigation. In Soybean, at the overall level 91.49 per cent cultivators were adopted recommended variety viz; Phule Kalyani and JS 335. About, 85.95 per cent cultivators used the recommended spacing and were followed by preparation of land 63.09 per cent. The highest 87.55 per cent technology adoption of Gram at overall level was observed in use of recommended variety and was followed by spacing 85.94 per cent and seed rate 71.54 per cent. Only 18.71 per cent of the cultivators were used recommended manure and 21.63 per cent of the cultivators were used recommended plant protection. In *rabi* Sorghum, Soybean and Gram the total yield gap was in the range of 21.66 to 40.27, 06.68 to 35.77 and 27.86 to 46.71 per cent respectively. It indicates that, the total yield gap was maximum in Gram crop was followed by *rabi* Sorghum and Soybean among the different level of adoption.

Keywords: Technology adoption, yield gap, foodgrain crops

Introduction
Major avenues for future to increase in foodgrains production are expected to come from the enhancement in productivity of foodgrain crops. To realize this expectation, a proper mix of technologies and strategies needs to be put in place. Given the difficulties involved in increasing the area under foodgrain crops, a combination of land-saving technologies involving high-yielding varieties, and efficient crop management need to be adopted. The unrealized yield due to lack of adoption of proper nutrient management has also been brought out. In this backdrop, adoption of integrated pest management and balanced and integrated crop nutrition should be stressed for foodgrain crops. The advantage of mechanization in foodgrain crops is a least understood and often neglected area. To realize the benefits of mechanization in foodgrains will help in enhancing the productivity of foodgrain crops. All these technological components do involve expansion of area under cultivation and are classified as land-saving technologies. Such technologies need to be promoted for enhancing productivity of foodgrain crops. An exhaustive review of innovative technologies available for foodgrain crops has shown that many technological avenues lie underutilized in pursuit of enhancement of foodgrain productivity. Some of the emerging fields of crop management research offer a considerable potential in improving the yield of foodgrain crops. Latest scientific and technological innovations in agro-techniques and enhancement in input-use efficiency need to be put to test and promising technologies among these need to be promoted to provide a strong technological push for foodgrain productivity enhancement. Promotion of Resource Conservation Technologies (RCT), Precision Farming, Contingency Crop Planning (CCP), Crop Modeling and Simulation offer significant potential for the productivity enhancement. Sorghum [*Sorghum bicolor* (L.), Moench.] belongs to family *Graminae*. Sorghum is considered to be originated in Ethiopia or East Central Africa. It is the fourth most important cereal following Wheat, Rice and Maize in the World as far as area under Sorghum and its production is concerned. It is grown as *kharif*, *rabi* and also as summer Sorghum. Soybean (*Glycine max*) belongs to the family *fabaceae* or *leguminosae* (legume), which also

includes peanuts, chickpea, other beans and pulses. Chickpea (*Cicer Arietinum* L.) commonly known as Gram or Bengal Gram is the most important pulse crop of India which alone has nearly 68 per cent of the World acreage.

Objectives

i. To examine the level of technology adoption in major foodgrain crops.
ii. To examine the yield gaps analysis in major foodgrain crops.

Materials and Methods

i. Selection of Cultivators

Western Maharashtra was selected for the study of foodgrain crops where the area under these foodgrain crops is concentrated. Three major foodgrain crops from the western Maharashtra region viz; *rabi* Sorghum, Soybean and Gram was selected on the basis of important crop of the region. Three districts from western Maharashtra region *viz.*, Solapur for *rabi* sorghum, Sangli for soybean and Ahmednagar for gram were selected on the basis of maximum area under respective crop of the district. Two tahsils from one district *viz.*, Solapur (Barshi and Mangalweda), Sangli (Walwa and Miraj) and Ahmednagar (Kopergaon and Sangamner) were selected on the basis of maximum area. Three villages from each tahsil were selected on the basis of maximum area under selected crop. In all, 18 villages i.e. 6 villages from each district for the region were selected, for each selected crop separately. For *rabi* Sorghum, Soybean and Gram 15 farmers were randomly selected from each village, i.e. 5 from small size group (i.e., 0.01-1.00 ha), 5 from medium size group (1.01 to 2.00 ha) and 5 from large size group (above 2.00 ha). Thus, 90 samples of *rabi* Sorghum, 90 samples of Soybean and 90 samples of Gram cultivators were selected randomly. For each crop 90 samples was comprised of 30 small, 30 medium and 30 large sample cultivators. Total samples were 270 for three foodgrain together.

ii. Technology Adoption Index

To assess the extent of adoption of improved crop production technology of *rabi* Sorghum, Gram and Soybean crop, the concept of technology adoption index was used. The score was assigned to each technology separately. Technology Adoption Index (TAI) was worked out with the help of following formula,

$$TAI = (Ai / Mi) * 100$$

Where,
Ai = Average adoption score registered by the farmer for particular component
Mi = Maximum adoption score registered for the particular component
After estimating the TAI, the TAI was arranged by ascending order and then the adopter were categorized into low, medium and high adopters.

iii. Distribution of sample cultivators

The selected sample cultivators were grouped as low, medium and high adopters on the basis of estimated TAI

Low adopter : Less than (Mean - SD)
Medium adopter : (Mean - SD to Mean + SD)
High adopter : Greater than (Mean + SD)

iv. Yield gap analysis

For this purpose three yield gap were estimated. In yield gap-I, farmers average yield compared with recommended yield. In yield gap-II, between progressive farmer yield and average farmers yield and yield gap-III is a total yield gap i.e. the average of recommended and progressive farmers yield compared with sample farmer's average yield.

A. Index of yield gap-I
$$I (Yg\text{-}I) = [R (Fy) - A (Fy)/R (Fy) \times 100] -100$$

B. Index of yield gap-II
$$I (Yg\text{-}II) = [P (Fy) - A (Fy)/R (Fy) \times 100] -100$$

C. Index of yield gap-III
$$I (Yg\text{-}III) = [R (Fy) + P (Fy)/2 * 100] -100$$

Results

i. Categorywise Distribution of Selected Cultivators

A) Categorywise distribution of selected *rabi* Sorghum cultivators in Solapur district

Even though the technology package for different crops has been developed by the Agricultural Universities for respective region, it is important to examine the extent of adoption and its impact. Hence, the Technology Adoption Index for each technology and cultivator has been estimated to classify the individual farmer into low, medium and high adopters.

Table 1: Categorywise distribution of selected *rabi* Sorghum cultivators in Solapur district

Sr. No.	Adopter	Number of cultivator	Area adopted (ha)
1	Low (below 48.06)	15.00 (16.67)	06.37 (10.63)
2	Medium (48.07 to 69.66)	61.00 (67.78)	42.52 (70.94)
3	High (69.67 & above)	14.00 (15.56)	11.05 (18.43)
	Total	90.00 (100.00)	59.94 (100.00)
	Mean = 58.86 SD = 10.80		

It was noted from Table 1 that, out of 90 cultivators, 15 cultivators were categorized under low technology adoption group. Accordingly, 61 cultivators were categorized in medium technology adoption group, while there was 14 cultivators comes under high technology adoption group.

B) Categorywise distribution of selected Soybean cultivators in Sangli district

It was noted from Table 2 that, out of 90 cultivators, 13 cultivators were categorized under low technology adoption group. Accordingly, 56 cultivators were categorized in medium technology adoption group, while there was 21 cultivators comes under high technology adoption group.

Table 2: Categorywise distribution of selected Soybean cultivators in Sangli district

Sr. No.	Adopter	Number of cultivator	Area adopted (ha)
1	Low (below 47.95)	13.00 (14.44)	21.97 (29.27)
2	Medium (47.96 to 75.65)	56.00 (62.22)	37.00 (49.29)
3	High (75.66 & above)	21.00 (23.33)	16.09 (21.43)
	Total	90.00 (100.00)	75.06 (100.00)
	Mean = 61.80 SD = 13.85		

C) Categorywise distribution of selected Gram cultivators in Ahmednagar district

It was noted from Table 3 that, out of 90 cultivators, 14, 62 and 14 cultivators were categorized low, medium and high technology adoption group, respectively.

Table 3: Categorywise distribution of selected Gram cultivators in Ahmednagar district

Sr. No.	Adopter	Number of cultivator	Area adopted (ha)
1	Low (below 46.07)	14.00 (15.55)	21.24 (29.54)
2	Medium (46.08 to 68.71)	62.00 (68.90)	40.32 (56.08)
3	High (68.72 & above)	14.00 (15.55)	10.33 (14.36)
	Total	90.00 (100.00)	71.89 (100.00)
	Mean = 57.57 SD = 10.87		

ii. Extent of Technology Adoption

Adoption of technology refers to actual practices adopted by the cultivators for cultivation of particular crop. The State Agricultural Universities (SAU's) have undertaken various research programmes for different crops. And for that, they have made various recommendations about technologies. For the present study, preparatory tillage, variety, time of sowing, spacing, use of seed rate, seed treatment, application of manures, fertilizer doses (N, P and K), crop management (includes weeding, hoeing, gap filling, thinning, etc.), plant protection, irrigation, etc. were studied for calculating total impact of all these components on the yield obtained of *rabi* Sorghum, Gram and Soybean.

A) Extent of Technology Adoption in *Rabi* Sorghum in Solapur district

The average of individual technology adopted by group of *rabi* Sorghum cultivators in Solapur district is presented in Table 4. It was found that, at overall level of adoption the 92.63 per cent cultivators were adopted recommended spacing for sowing. It was due to maintaining plant population. About, 85.48 per cent of the cultivators used the recommended varieties by the university. It was due to higher yield of Sorghum grain and fodder of university released Sorghum varieties than local varieties. It was also found that, at overall level of adoption the cultivators were adopting protected irrigation (80.58%). Only 34.02 per cent of the cultivators were used recommended dose of nitrogen and 39.89 per cent of the cultivators were used recommended dose of potassium.

Table 4: Extent of technology adoption in *rabi* Sorghum in Solapur district (%)

Sr. No.	Technology	Adopter			Overall
		Low	Medium	High	
1	Soil type	66.66	73.77	92.85	77.76
2	Preparation of land	36.66	46.72	44.64	52.67
3	Variety	80.00	83.60	92.85	85.48
4	Sowing time	33.33	77.04	71.42	60.59
5	Spacing	80.00	98.36	99.54	92.63
6	Seed rate	68.33	70.90	78.57	72.60
7	Seed treatment	20.00	32.78	92.85	48.54
8	Manure	16.66	52.45	83.92	51.01
9	Nitrogen	11.66	42.21	48.21	34.02
10	Phosphorus	26.66	43.85	58.92	43.14
11	Potassium	25.00	39.34	55.35	39.89
12	Intercultural operations	65.00	78.27	87.5	76.92
13	Irrigation	61.10	83.05	97.61	80.58
14	Plant protection	42.30	59.16	49.99	50.48
	Average	45.24	62.97	75.30	61.88

B) Extent of technology adoption in Soybean in Sangli district

The average of individual technology adopted by group of Soybean cultivators in Sangli district is presented in Table 5. It was found that, at overall level of adoption the 91.49 per cent cultivators were adopted recommended variety for sowing. It might be due to variety Phule Kalyani and JS-335. About, 85.95 per cent cultivators used the recommended spacing by the given university. It may be due to maintaining plant population. It was also found that, at overall level of adoption the cultivators were adopting proper seed rate (66.92%). Only 25.36 per cent of the cultivators were used recommended plant protection and 37.66 per cent of the cultivators were used recommended dose of phosphorus.

Table 5: Extent of technology adoption in Soybean in Sangli district (%)

Sr. No.	Technology	Adopter			Overall
		Low	Medium	High	
1	Soil type	23.07	17.85	85.71	42.21
2	Preparation of land	33.33	60.71	95.23	63.09
3	Variety	84.61	94.64	95.23	91.49
4	Sowing time	23.07	35.71	85.71	48.16
5	Spacing	76.92	85.71	95.23	85.95
6	Seed rate	67.30	69.19	64.28	66.92
7	Seed treatment	15.38	78.57	95.23	63.06
8	Manure	32.69	38.82	35.71	35.74
9	Nitrogen	51.92	50.44	48.80	50.38
10	Phosphorus	13.46	40.62	58.92	37.66
11	Intercultural operations	34.61	33.05	95.23	54.29
12	Irrigation	11.53	43.75	73.80	43.02
13	Plant protection	15.38	25.00	35.71	25.36
	Average	37.18	51.85	74.22	54.41

C) Extent of technology adoption in Gram in Ahmednagar district

The average of individual technology adopted by group of Gram cultivators in Ahmednagar district is presented in Table 6. It was found that, at overall level of adoption the 87.55 per cent cultivators were adopted recommended variety for sowing. It might be due to use of university released Gram varieties than local varieties. About, 85.94 per cent cultivators used the recommended spacing by the given university. It may be due to maintaining plant population. It was also found that, at overall level of adoption the cultivators were adopting recommended dose of nitrogen (72.46%). Only 18.71 per cent of the cultivators were used recommended dose of manures and 21.63 per cent of the cultivators were used recommended plant protection. The findings are in line with the results of Khalid (2000) [3], Singh *et al.* (2008) [8] and Nimbalkar *et al.* (2014) [5].

Table 6: Extent of adoption of technologies in Gram in Ahmednagar district (%)

Sr. No.	Technology	Adopter			Overall
		Low	Medium	High	
1	Soil type	28.57	85.48	85.71	66.59
2	Preparation of land	50.00	64.51	78.57	64.36
3	Variety	71.42	98.38	92.85	87.55
4	Sowing time	57.14	45.16	71.42	57.91
5	Spacing	71.42	93.54	92.85	85.94
6	Seed rate	64.28	71.77	78.57	71.54
7	Seed treatment	14.28	37.09	78.57	43.31
8	Manure	08.92	13.30	33.92	18.71
9	Nitrogen	69.64	70.96	76.78	72.46
10	Phosphorus	28.57	50.80	64.28	47.88
11	Potassium	26.78	33.06	35.71	31.85
12	Intercultural operations	52.38	63.44	59.52	58.45
13	Irrigation	52.38	67.74	80.95	67.02
14	Plant protection	07.14	24.19	33.57	21.63
	Average	43.07	58.53	68.805	56.8

iii. Yield Gap Analysis

A) Yield gap analysis of *rabi* Sorghum in Solapur district

It was evident from the Table 7 that, at the overall level potential yield gap (Yield Gap–I) and progressive farmer yield gap (Yield Gap-II) for *rabi* Sorghum was worked out to 36.64 and 19.16 per cent, respectively. However, the gap at average farmer yield level (Total Yield Gap) was worked out to 29.00 per cent. The total yield gap was maximum in low adopter groups (40.27%) and was followed by medium (34.22%) and large (23.53%) adopter groups.

Table 7: Yield gap analysis of *rabi* Sorghum in Solapur district (ha)

Sr. No.	Particulars		Adopter			Overall
			Low	Medium	High	
1	Yield Gap I	Potential yield (q)	25.00	25.00	25.00	25.00
		Actual	13.20	15.05	19.27	15.84
		Gap	11.80	09.95	05.73	09.16
		% Gap	47.20	39.80	22.90	36.64
2	Yield Gap II	Progressive farmers yield (q)	19.20	20.76	24.20	19.62
		Actual	13.20	15.05	19.27	15.84
		Gap	06.00	05.71	04.93	03.78
		% Gap	31.25	27.50	20.40	19.26
3	Total Yield Gap	Average yield Gap (q)	22.10	22.88	24.60	22.31
		Actual	13.20	15.05	19.27	15.84
		Gap	08.90	07.83	05.33	06.47
		% Gap	40.27	34.22	21.66	29.00

B) Yield gap analysis of Soybean in Sangli district

It was evident from the Table 8 that, at the overall level potential yield gap (Yield Gap–I) and progressive farmer yield gap (Yield Gap-II) for Soybean was worked out to 28.72 and 10.76 per cent, respectively. However, the average farmer yield gap (Total Yield Gap) was worked out to 23.21 per cent. The total yield gap was maximum in low adopter groups (35.77%) followed by medium (29.19%) and large (06.68%) adopter groups.

Table 8: Yield gap analysis of Soybean in Sangli district (ha)

Sr. No.	Particulars		Adopter			Overall
			Low	Medium	High	
1	Yield Gap I	Potential yield (q)	25.00	25.00	25.00	25.00
		Actual	14.00	16.18	23.30	17.82
		Gap	11.00	08.82	01.70	07.18
		% gap	44.00	35.28	06.80	28.72
2	Yield Gap II	Progressive farmers yield (q)	18.60	20.70	24.94	21.41
		Actual	14.00	16.18	23.30	17.82
		Gap	04.60	04.52	01.45	03.12
		% gap	24.73	21.83	05.85	16.76
3	Total Yield Gap	Average yield Gap (q)	21.80	22.85	24.97	23.20
		Actual	14.00	16.18	23.3	17.82
		Gap	07.80	06.67	01.67	05.38
		% Gap	35.77	29.19	06.68	23.21

C) Yield gap analysis of Gram in Ahmednagar district

It was evident from the Table 9 that, at the overall level potential yield gap (Yield Gap–I) and progressive farmer yield gap (Yield Gap-II) for Gram was worked out to 43.92 and 28.76 per cent, respectively. However, the average farmer yield gap (Total Yield Gap) was worked out to 37.24 per cent. The total yield gap was maximum in low adopter groups (46.71%) and followed by medium (39.15%) and large (27.86%) adopter groups.

From the above discussion, not only adoption of production technology was the sole reason for such a huge gap in the production levels but also the imbalanced application of inputs was also associated with the same. That can be observed among the different adoption levles which indicates that as the level of adoption increased the percentages of gap between potential

Table 9: Yield gap analysis of Gram in Ahmednagar district (ha)

Sr. No.	Particulars		Adopter			Overall
			Low	Medium	High	
1	Yield Gap I	Potential yield (q)	25.00	25.00	25.00	25.00
		Actual	10.83	13.25	17.98	14.02
		Gap	14.17	11.75	07.02	10.98
		% gap	56.68	47.00	28.08	43.92
2	Yield Gap II	Progressive farmers yield (q)	15.65	18.55	24.85	19.68
		Actual	10.83	13.25	17.98	14.02
		Gap	04.82	05.30	06.87	05.30
		% gap	30.79	28.57	27.64	28.76

3	Total Yield Gap	Average yield Gap (q)	20.32	21.77	24.92	22.34
		Actual	10.83	13.25	17.98	14.02
		Gap	09.49	08.52	06.94	08.32
		% Gap	46.71	39.15	27.86	37.24

and actual yields has decreased considerably. The similar findings were noted by Bhatia *et al.* (2008) [1] and Choudhary *et al.* (2009) [2].

Conclusion

i. Technology of spacing, variety and irrigation was adopted by the *rabi* Sorghum cultivators; variety, spacing and seed rate was adopted by Soybean cultivators and variety, spacing and nitrogen was adopted by Gram cultivators upto maximum extent.
ii. The recommended technologies were not properly adopted by low and medium adopter groups viz; preparation of land, seed treatment, sowing time and nutrient management. The extent of technology adoption for *rabi* Sorghum, Soybean and Gram crops ware low on cultivator's field. Therefore, the efforts are required to be made to intensify extension education activity to increase awareness among the *rabi* Sorghum, Soybean and Gram cultivators so as to accelerate the process of technology adoption.
iii. For output maximization and cost minimization, the cultivators shall adopt the recommended technology packages viz., variety and seed application, nutrient management, preparatory tillage and intercultural operations.
iv. The yield gap was maximum in low adoption groups and declining over the adoption groups in *rabi* Sorghum, Soybran and Gram crop.

References

1. Bhatia VS, Singh P, Wani SP, Chauhan GS, Rao K, Mishra AK *et al*. Analysis of potential yields and yield gaps of rainfed Soybean in India using CROPGRO-Soybean model. Journal of Agricultural and Forest Meteorology, 2008; 48(2):252-265.
2. Choudhary AK, Yadav DS. Technological and extension yield gaps in oilseeds in Mandi district of Himachal Pradesh. Indian Journal of Soil Conservation. 2009; 37(3):224-229.
3. Khalid MT. Adoption of recommended practices of Soybean cultivation by farmers in Lodharn tahsil of Pakistan. International Journal of Agriculture and Biology. 2000 2(4):336-338.
4. Meena KC. Extent of adoption level of the respondents about Soybean production technologies in Baran district of Rajasthan. Rajasthan Journal of Extension Education. 2011; 19:133-138.
5. Nimbalkar CS, Wani VS, Shinde SD. A study of technology adoption gap in Gram: A Principle Component Approach. AGRESCO Report, Department of Statistics, MPKV, Rahuri, 2014, 9-16.
6. Pokharkar VG, Sonawane KG, Gulave CM. Impact of improved production technology of Groundnut (*Arachis hypogaea* L.) on farm productivity and income in western Maharashtra. Journal of Oilseeds Research. 2014; 33(2):138-145.
7. Shiyani RL, Joshi PK, Bantilan MCS. Adoption of improved Chick pea varieties, evidences from tribal region of Gujarat. Indian Journal of Agriculture Economics. 2000; 55(2):1-5.
8. Singh M, Dwiwedi AP, Mishra A, Singh RP, Singh D, Singh SRK, Chand P. Adoption level and constraints in Soybean production technology in Sagar district of Madhya Pradesh. Journal of Community Mobilization and Sustainable Development. 2008; 8(1):94-99.
9. Srinivas A, Govardhan Rao V, Jyothi S. Yield gap analysis of Sorghum through front line demonstrations in tribal area of east Godavari district, Andhra Pradesh. International Journal of Engineering Science and Innovative Technology. 2014; 3(6):642-646.